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SCREENING PROCEDURE FOR CANDIDATE FUMIGANTS FOR STORED GRAIN AND GRAIN PRODUCTS

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Each year many new chemicals are submitted to the Manhattan, Kans., station for testing as fumigants for stored grain and grain products. It would be impractical and unwise to conduct large-scale tests with every compound so submitted for screening. The screening procedure described herein is designed to establish the minimum lethal dosage of the candidate compounds, both in space and in commodities, and their performance under various conditions. By this procedure a candidate fumigant can be evaluated in the laboratory at normal atmospheric pressure.

By use of this procedure not only may promising new fumigants be discovered, but dosages may be established for large-scale tests in warehouses and other storage facilities.

Before tests are started to evaluate the candidate compound, its physical and chemical properties are reviewed. Many compounds may be eliminated because of objectionable odor, flammability, corrosiveness to metal, deleterious effect on the viability of seed grain, or other objectionable properties. Also its toxicity to man is considered, and any necessary precautions in handling the fumigant are observed. Germination tests are conducted if the compound shows promise as a fumigant.

The confused flour beetle (Tribolium confusum Duv.) and the rice weevil (Sitophilus oryza (L.)) are used to determine the comparative toxicity of the fumigant being studied, as these species represent, respectively, the more resistant and susceptible types of insects infesting stored grain.

It is essential to have the condition and age of the test insects as nearly uniform as possible. To provide a continuing supply, cultures are started at weekly intervals. The insects are reared in a uniform food medium under constant temperature (80° F.) and humidity (70 percent), and tested as adults.

The tests are conducted in empty glass flasks and in empty glass cylinders, to determine the fumigant's toxicity in space, and then in similar cylinders filled with a commodity. Before being exposed in these containers the insects are placed in 45-mesh screen cages 1/2 inch in diameter and 2 1/2 inches long (fig. 1), 30 insects to a cage. The cages have cork stoppers impregnated with hot paraffin to prevent sorption of the fumigant and to keep the insects from boring into the corks.

The fumigant is first tested in a 20-liter flask (fig. 2). A glass tube passing through a rubber stopper is connected to a glass stopcock outside the flask. Two cages, containing insects of each species separately, are suspended in the center of the flask. A partial vacuum (about 20 inches) is made in the flask to facilitate introduction of the fumigant. A measured dosage of liquid fumigant in a pipette is then held over the end of the glass tube extending from the stopcock, and introduced by opening the stopcock and allowing the vacuum to draw the fumigant into the flask. After an exposure of 20 hours the insects are examined for mortality. As a check on possible recovery a second observation is made 5 days later. These tests are run in 3 to 5 replicates and are repeated until the minimum lethal dosage is determined.

In the next [illegible] a glass cylinder 7 3/8 inches in diameter and 6 feet high is used (fig. 3). This cylinder consists of sections 1 foot high, taped together with 1-inch plastic tape, and the ends are closed with disks of tempered Masonite impregnated with paraffin. The cages containing the test insects are suspended within the cylinder at three levels--1 inch from the bottom, in the center, and 1 inch from the top. A plastic gas-sampling tube is placed beside each cage, and passed to the outside through a hole in the top Masonite disk. Through another hole in this disk the liquid fumigant is introduced into a flat-bottomed dish suspended at the top of the cylinder. Gas samples are withdrawn at intervals to determine the distribution and concentration of the fumigant. The mortality is determined in the same manner as in the flask tests.

The behavior of the fumigant in cylinders filled with wheat or its milling fractions or with various other commodities is now studied. These tests are made in the same manner as those in the empty cylinder except that the fumigant is introduced directly onto the surface of the commodity. In these tests the performance of the fumigant may be observed under several conditions--(1) with the cylinder completely sealed, (2) with the top open and the bottom sealed, (3) with the top sealed and a plastic tube sealed into the bottom to provide drainage, and (4) with the top open and the drainage tube in the bottom.

If desired, the fumigant may be re-circulated by means of a blower (fig. 4). This closed system may be used with either empty or filled

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cylinders. In this way the minimum lethal dosage and the dispersion of the gas may be determined, and also the time required for aeration of a product after fumigation.

All the fumigation tests are conducted in a room where a temperature of 80° F. is thermostatically maintained. Small variations of the temperature during the exposure period are recorded, but usually they do not appreciably influence the results.

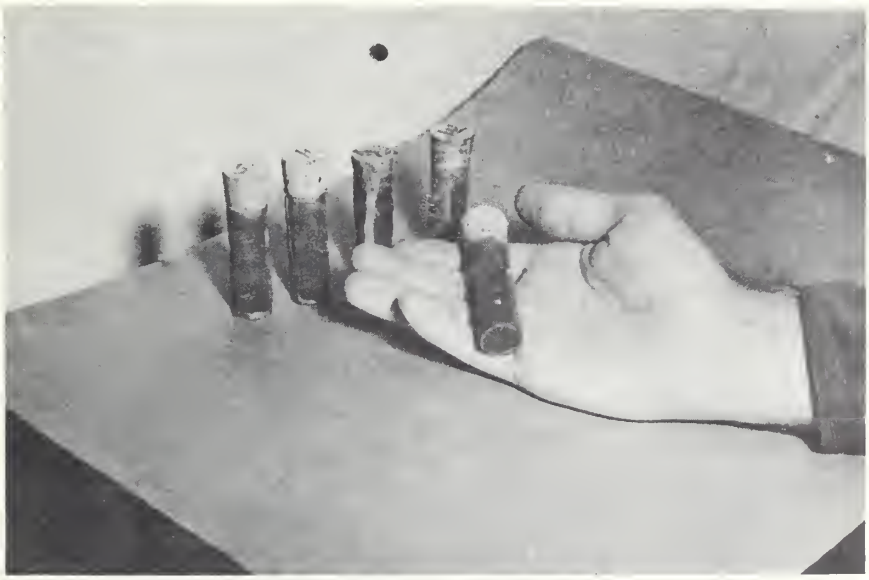

Figure 1.--Wire-screen cages for the test insects.

Figure 2.--A 20-liter flask with stopcock and suspended test cages. The amount of vacuum in the flask is being checked with a manometer prior to the introduction of a measured amount of fumigant.

Figure 3.--An empty glass cylinder and a glass cylinder filled with wheat. A gas sample is being drawn from the wheat-filled cylinder for a chemical analysis to determine the gas concentration.

Figure 4.--A cylinder equipped with a blower at the bottom and a pipe to recirculate the fumigant. Heat is being applied to the liquid fumigant in the test tube to volatilize it. An infrared lamp prevents condensation of the gas in the delivery tube. Water is forced pneumatically from the flask into the test tube in insure introduction of the entire dosage of fumigant into the recirculation system.

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